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ABSTRACT

The San Diego High School Science Teacher Development Program was designed to address the lack of skills in communication and analytical reasoning and the need for increased scientific literacy at seven urban high schools in San Diego whose student populations from minority ethnic backgrounds exceed 50%. Among project objectives were: to improve the science achievement of college bound students, the basic language and math skills of students in high school science, and academic counseling for students to prepare for possible science or technical majors in college; and to develop a model for high school/university cooperation. The project included provisions for San Diego State faculty consultants and student tutors (science majors) to be at the school site. It also provided support for in-service professional training for high school teachers. After 3 years of the project, all indications indicated that: the project encouraged meaningful cooperation between high school and university faculty; all seven schools improved in basic language and math skills more than the district as a whole; and Writing Across the Curriculum programs have a synergistic positive effect on writing ability. Appended are an assessment of science student writing; results from analysis of the IPSP Problem Solving test; a copy of the Maxigrant Continuation questionnaire; and the 1985/86 roster of the San Diego High School Teacher Development program. (Author/SM)

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SAN DIEGO HIGH SCHOOL
SCIENCE TEACHER DEVELOPMENT PROGRAM

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AASCU/ERIC Model Programs Inventory Project

The AASCU/ERIC Model Programs Inventory is a two-year project seeking to establish and test a model system for collecting and disseminating information on model programs at AASCU-member institutions--375 of the public four-year colleges and universities in the United States.

The four objectives of the project are:

- To increase the information on model programs available to all institutions through the ERIC system
- To encourage the use of the ERIC system by AASCU institutions
- To improve AASCU's ability to know about, and share information on, activities at member institutions, and
- To test a model for collaboration with ERIC that other national organizations might adopt.

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I. Executive Summary

The project, San Diego High School Science Teacher Development Program (NSF/DPE-8470394), addressed simultaneously the problems of the lack of skills in communication and analytical reasoning and the need for increased scientific literacy at seven large, urban high schools in San Diego, California, whose student populations from minority ethnic backgrounds exceeded fifty percent.

The project included provisions for San Diego State University (SDSU) faculty consultants and student tutors who were science majors to be at the school site. It also provided support for in-service professional training for high school science teachers. Ten university faculty, fourteen undergraduate science/engineering majors and twenty-four high school science teachers participated in this project. Approximately 2,500 high school students were directly affected by this project.

After three years of the project, some findings are indicated. All evaluations indicated that the project has stimulated and encouraged meaningful cooperation and rapport between high school teachers and California State University (CSU) faculty. The workshops held and follow-up support provided by the project have improved the ability of science teachers to integrate communication skills, reasoning ability and analytical skills of students in high school science. The Frontiers of Science Lecture Series provided a large number of students and teachers the opportunity to view science and engineering research first hand and to receive counseling about careers in those areas. The teachers all required substantially more writing from their students. Teachers reported that their students showed increased interest, better grades, and a better attitude toward learning science. According to a comparison of basic language and mathematics skills in 1982 and 1984, all seven schools improved over the two year period more than the district as a whole.

In the last year of the project, significant findings demonstrated that the students definitely improved their writing abilities. This supports the hypothesis that Writing Across The Curriculum programs have a synergistic positive effect on writing ability.

The project warrants close analysis as a potential model for the CSU system as an interim program to reduce the need for CSU remedial programs on the CSU campuses. The potential success of the students at CSU campuses and the potential selection of science or engineering careers by the students has yet to be demonstrated.

Several factors have been important to the success of the program. The multi-faceted design of the approach has been excellent. Finding CSU science faculty willing to spend substantial time at high schools has been crucial. Providing teacher stipends has been a key motivating factor. In addition, regular use of college student tutors in the high school classroom was crucial to the success of this program. Having CSU writing instructors at the high schools (from another project) was also beneficial in providing support on the site.

II. A. Objectives

The overall objectives of this project were:

1. to improve the science achievement of college-bound students in biology, chemistry and physics in grades 10-12 at seven urban high schools;

2. to improve the ability of science teachers to integrate communications skills, reasoning ability, and analytical skills of students in high school science;

3. to improve the basic language and mathematics skills of students in high school science;

4. to improve the counseling of students regarding background courses needed in high school to prepare for possible science or technical majors in college;

5. to help motivate high school students seriously consider careers in the sciences and science-related areas;

6. to stimulate and encourage meaningful cooperation and rapport between teachers in high schools and the CSU faculty; and

7. to develop a model for high school/university cooperation.

B. Statement of the Problem

The Commission of Precollege Education in Mathematics, Science, and Technology submitted its report, Today's Problems, Tomorrow's Crises, to the National Science Foundation in 1982. The Commission found that

> there is an escalating awareness of the inordinate difficulties that our educational systems are facing in trying to meet the needs of the Nation in our changing and increasingly technological society. We appear to be raising a generation of Americans who lack the understanding and the skills necessary to participate fully in the technological world in which they live and work. Improved preparation of all citizens in the fields of mathematics, science, and technology is essential to the development and maintenance of our Nation's economic strength, military security, commitment to the democratic ideal of an informed and participating citizenry, and leadership in mathematics, science and technology. . . .
>
> To meet these ends, our education systems must have the commitment and the capacity to achieve three equally important goals: 1) to continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering; 2) to widen the range of high quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically oriented careers and professions; and 3) to increase the general mathematical ability and understanding of science and technology by all citizens for life, work, and full participation in the society of the future. . . .
>
> In addition, wide differences persist in achievement and participation levels among students from different social groups. Women have traditionally participated less than men in science. Also, members of various minority groups (particularly American Indians, Black Americans, Mexican Americans, and Puerto Ricans) have participated less often and performed less well on standard science and mathematics achievement tests than their white counterparts. Approximately 20 percentage points separated 17-year-old black and white students on national assessment tests in both 1973 and 1978.

Approximately 15 percentage points separated 17-year-old Hispanics and whites in both years.

A substantial number of students who enter California colleges and universities are not prepared for college level work. Deficiencies in basic skills, particularly in English and mathematics prevail despite the special importance of competence in these areas. Adequate preparation in English and mathematics is needed to provide basic skills in communication and analysis, not only to prepare students for additional work in these disciplines but also to provide access to other disciplines and prepare students for a wide spectrum of career choices.

Students who plan to continue their education at a college or university must have a clear understanding of what basic academic skills will be expected of them. As beginning freshmen, students should have to display competence in writing, reading, and mathematics.

III. Methods

A. Planning

The planning was carried out with close consultation between the science supervisors of the school district, the principals of the target schools, science teachers (one from each high school) and SDSU faculty including the co-directors. The seven high schools were: Clairemont, Crawford, Hoover, Kearney, Lincoln, Morse, and San Diego. The high schools were selected because they had the lowest scores in the San Diego Unified School District on the 1982 Comprehensive Test of Basic Skills for grade eleven percentile rankings.

B. Approach

As stated earlier, one of the major goals of the project was to integrate communication skills and problem solving into science courses. We proposed that the best way to increase the understanding of science by students is to integrate reading, writing, and problem-solving skills into the science classes (Thelen, 1982). The mastering of these skills, which support successful academic performances in all areas, would have an immediate positive impact on student grades (Collins, 1979). The skills were not taught as isolated, additional content but, rather, were introduced parallel to and integrated with regular science content (Taylor and Berkowitz, 1980).

The model for this project was the Science Training Enrichment Program developed by a consortium including DePaul University, the International Business Machines

Corporation (IBM) and sixty-seven high schools in Indiana. The Science Training Enrichment Program has been operating for several years and has shown success in the academic improvement of science students and the professional improvement of science teachers. A report of this project was published in the Journal of College Science Teaching (Ricketts and Kissinger, 1982). Five of the major cornerstones of that program were used in this project:

1) in-service teacher education
2) science lecture series
3) university faculty consultants
4) student tutors
5) counseling

In addition, this project had workshops and other continuing education on integrating basic skills instruction in science teaching.

In-service Education for Science Teachers

Before the high school year began, a workshop attended by the science teachers, student tutors and university faculty consultants was held at the County Board of Education Building by the Co-Directors of this project. The science teachers and student tutors received participant stipends. The workshop provided techniques for integrating communication and problem-solving skills into the high school science program. During the year, university faculty and student tutors worked with the high school teachers in the application of the techniques. The SDSU Academic Skills Center assigned additional faculty support for this program who provided continuing support during the year.

The communication aspect of the workshop centered on using the Writing Guides developed by Dr. Charles Cooper of the University of California at San Diego. In addition, materials developed by the Academic Skills Center at San Diego State University for "writing across the curriculum" were used in the workshop.

Quantitative differences appeared in the percentages between pre-test and post-test for the writing component. The students from the three schools new to the program showed marked improvements in their writing, but the percentages for the students who were in the program for the year were even more impressive. Students from Crawford, Kearny, and Clairmont High Schools (the schools added to the program at mid-year) showed an improvement of 6% on the good writing, 26% on the adequate writing, and 14% on the minimal writing. This left 17% fewer students in the inadequate writing category. However, the scores of students from Hoover, Lincoln, Morse, and San Diego High Schools improved more dramatically. These students,

in the program for the full year, more than doubled the number of students in the good writing category, and the number in the adequate writing category increased by 14%. The minimal writing category remained almost the same, but the inadequate writing category dropped by 23%.

For the science component, it should be noted that the mean scores on both the pre-test and the post-test for all three parts of the IPSP Problem Solving Test as well as for the total score are relatively high. In fact, 56% of the students scored 8 or better on Part I, 50.6% scored 8 or better on Part II, and 45.2% scored 8 or better on Part III, with 20.7%, 7%, and 10.4% of the students getting all of the items correct on Parts I, II, III, respectively. One would expect the scores of the high scoring students to have a tendency to regress toward the mean. To be sure it would be difficult for many of these students to improve their scores. The complete frequency tables for both the pre-test and the post-test are contained in Appendix B.

Frontiers of Science Lecture Series

The community resources are especially rich in scientific and engineering research. Internationally recognized researchers from university, government and industry gave public lectures on their research. Each of the seven participating high schools were allocated an annual budget of $500 to use as stipends for the lecture series. Some high schools allowed all of the targeted students in the school to attend the lectures and on other occasions conducted specialized lectures in the classrooms. Some schools also used these lectures as evening programs to bring parents onto the campus.

University Faculty Consultants

An SDSU science faculty member was assigned to each high school and spent a minimum of five hours per week working with teachers and students at the school site. The term "faculty consultant" allows for the faculty member to have flexibility in services supplied. Among these services were:

1) classroom lectures,
2) consultation with science teachers about how to improve scientific literacy,
3) design of classroom laboratory experiences within a 50 minute class period,
4) material assistance given to the high school through equipment loans and by loans and gifts of such things as biological samples for student projects,
5) student counseling,

6) liaison between the high school and the university,
7) advice to students on science fair projects,
8) use of computers for homework assignments, and
9) supervision of student tutors.

The seven faculty members teach introductory courses required for the university general education science requirement. They included two physicists, a biochemist, and a historian of science. All of the faculty consultants had extensive experience teaching and lecturing in the high schools as former high school science teachers, as GATE (Gifted and Talented Education Program) lecturers, and under the "Meet the Scientist" program, for example.

Student Tutors

Two SDSU student tutors were at each school site for an average of ten hours per week. They assisted the science teachers in preparing classroom activities and assisted students in learning basic language and mathematics skills. The student tutors received special training in teaching communication skills at the pre-school year workshop. They were supervised by the SDSU faculty consultants and the co-directors. The student tutors played a crucial role in enabling the science teachers to assign more meaningful homework in order to develop communication and problem-solving skills. They worked directly with students on the completion of these assignments and assisted the teacher in grading. Since there are many demands on the teachers' time, the teachers have little time to grade the additional assignments. Still, students can only establish these new skills through the practice and application afforded them by the extra assignments. The presence of the tutors solved not only the problem of individual help for the students but also furnished someone to grade many of the assignments. Thus grading by student tutors overcame one of the major stumbling blocks in enabling students to achieve these necessary problem solving and writing skills.

In addition, a one-unit course, entitled "Experiences in Sciences Education," has been added to the University Science curriculum. Registration in this course requires that the university student spend three hours per week at one of the high schools working with the science teacher as an aide and tutor. This course simultaneously provides the student with the opportunity to experience and consider science teaching as a career without the formality of a credential program, and the high school science teacher with competent, free assistance. This aspect of the program has proven successful and, for that reason, is continuing after the project funding ended.

IV. Outcomes/Findings

A. Communication

The Projection directors, SDSU faculty consultants and high schools science department chairpersons met monthly to discuss the project activities, problems and other items important to the day-to-day operations. Periodic newsletters were also sent to all project participants and other interested parties.

B. Comprehensive Test of Basic Skills

A comparison of the 1982 and 1984 results of the CTBS for grade 11 at the seven high schools in this project shows that all seven increased their scores over the two year period in language and mathematics skills which are the skills addressed by this project. In language, the seven high schools improved 7.7 percentile points or 1.7 above the district improvement. In mathematics, the seven high schools improved 11.0 percentile points or 2.0 above the district imporvement (see Table 1 below).

C. Maxigrant Continuation Questionnaire

The SDSU faculty and high school science teachers were asked to rate program activities on a scale from (1) discontinue to (5) continue - high priority. Teachers rated these as high priority: SDSU Faculty liaison with SDSU campus (16 of 20 teachers), SDSU student science tutors (15 of 20) and Writing in Science Workshops (13 of 20). SDSU faculty ratings were varied with a majority of faculty agreeing on no activity as high proprity (Appendix C).

TABLE 1

COMPREHENSIVE TEST OF BASIC SKILLS
1982/84 Grade 11 Percentile Rankings

Seven Participating High Schools:

	READING		LANGUAGE		MATH	
	1982	1984	1982	1984	1982	1984
Clairemont	47	46	52	56	54	55
Crawford	59	48	60	64	57	66
Hoover	44	34	38	47	51	59
Kearny	49	27	44	50	53	66
Lincoln	23	16	25	31	32	44
Morse	48	37	46	56	47	64
San Diego	35	33	32	47	42	55
AVERAGES	44	34	42	50	48	58
1982/1984 DIFFERENCE	-10		8		10	

San Diego Unified School District:

	READING		LANGUAGE		MATH	
	1982	1984	1982	1984	1982	1984
(District Averages)	58	50	55	61	57	66
1982/1984 (District Difference)	-8		6		9	

D. Improvements During The Second Year

Notice the increase of improvement during the second year of this program in the following summary of an evaluation by the high school teachers:

1. Did you require more writing of your students than in the past?

		1984	1985
A.	Same but better organization	1	
B.	More (yes)	11	21
C.	No	0	0

Note: In 1984 one mentioned requiring more writing in all classes taught.

2. Was there any improvement beyond normal among your students this year in:

a. grades in science
b. writing ability
c. interest/attitude

		1984	1985
A.	Grades in science		
	(1) Improved	5	13
	(2) About the same	2	5
	(3) Unable to assess	3	
	(4) No response	2	
B.	Writing ability		
	(1) Improved	11	19
	(2) About the same	0	0
	(3) Not sure (first year)	1	
C.	Interest/Attitude		
	(1) Increased interest	11	13
	(2) About the same	0	1
	(3) Not sure	1	

3. How was your own enthusiasm for teaching affected by the maxigrant?

		1984	1985
A.	Increased enthusiasm	7	14
B.	Greatly increased enthusiasm	5	8
B.	Difficult to assess	1	0

Enthusiastic responses from 1985:

Better able to concentrate on in-depth curricula
Seeing student growth made me more enthusiastic

Increased science fair participation made me more enthusiastic
Expansion of science background
Own enthusiasm has influenced students
Stimulating new source of ideas
Writing support
Improvement in grades increased my enthusiasm

4. How do you plan to use the SDSU tutors next year?

Responses from 1985:

Assist students in doing research, in writing papers, and with science fair projects	4
More evaluation of student writing	1
More involvement in writing assignments and labs	1
Grading, labs	1
Lab preparations and student assignments	4
Increase tutor/student one-to-one relationships	1
Small work groups	1
Test reviews	1
Teach mini-units	1
Grade writing logo	1
Source of ideas	1
Increase responsibility	1
Readers	1

5. How do you plan to use SDSU faculty next year?

Responses from 1985:

More involvement in science fair	4
More feedback	1
More seminars to meet other faculty	1
More classroom teaching	6
More SDSU contacts	2
Writing assignments	1
Resource	1
Coordination	1
Obtain speakers	1

6. Do you have any suggestions about the lecture series?

Responses from 1985:

Workshops for emphasis on writing in science
Split series: 1/2 high school--1/2 SDSU
Careful selection of speakers
Provide list of potential speakers
Coordinate with other schools in selecting good speakers

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Guest scientist each month
Useful as parental involvement
Stimulating
Maintain flexibility in use of funds
Discontinue

7. Did you notice any changes in attitudes or achievement by your minority students that could be attributed to the maxigrant in any way (e.g., SDSU tutors, etc.)?

Yes	13
No	3

8. How many of your students participated in the Science Fair this year? Did the maxigrant contribute to the increase?

Yes	10
No	3

	1984	1985
Students articipating in Science Fair	99	320

9. Did you change your teaching style as a result of the maxigrant?

Yes	18
No	1

10. In general, how would you characterize the overall effect of the maxigrant?

Positive effect	16
Became a more effective teacher	2

Specific remarks 1985:

Participating in the maxigrant program has made me and my students more aware of the role of writing in the learning process.
The program increased the amount and quality of student writing.
Tutors performed a great service.
The faculty and tutors are excellent.
The program helped in its first year.
It was great--produced lasting changes.
Great improvement!
Very worthwhile!
Very good!
Increased this teacher's awareness of the importance of writing.

E. An Assessment of Science Student Writing: A Summary

The science student targeted for this assessment were high school students in Grades 9-12 from seven high schools with large numbers of minority students: Clairmont, Crawford, Hoover, Kearny, Lincoln, Morse, and San Diego High Schools. This year the students wrote their papers in the context of their regular science courses. Students in all grades had the same assignment. The day before the students wrote, they were given a copy of the essay. It was read to them and, as a group, they discussed the essay in class. They were not told the question on which they would be writing (see Appendix A, Attachment B:2).

The day of the writing they each were given a copy of the question and it was read aloud to them. They were not allowed to use notes or to refer to the essay. The writing task assigned and its assessment is discussed at greater length in Appendix A, (page 2). The writing samples were scored holistically by a group of instructors from SDSU (see Appendix A). The score results from the target population are discussed more fully in Appendix A (page 2, 3, and 4).

Quantitative differences appear in the percentages between pre-test and post-test. The students from the three schools new to the program showed marked improvements in their writing, but the percentages for the students who were in the program for the year were even more impressive. Students from Crawford, Kearny, and Clairmont High Schools (the schools new to the program) showed an improvement of 6% on the good writing, 26% on the adequate writing, and 14% on the minimal writing. This left 17% fewer students in the inadequate writing category. However, the scores of students from Hoover, Lincoln, Morse, and San Diego High Schools improved more dramatically. These students, in the program for the full year, more than doubled the number of students in the good writing category, and the number in the adequate writing category increased by 14%. The minimal writing category remained almost the same, but the inadequate writing category dropped by 23%.

When one considers, however, the students assessed in the target population, the results of this general assessment prove even more significant. These students came from seven predominantly minority isolated high schools who, on the basis of standardized tests, scored the lowest in the San Diego area. They represent those students whose basic skills fall below those of the general student population. Yet, when the two populations were compared in the writing assessment, the target population performed at a level equal to or better than the general population. This not only demonstrates the positive effect of incorporating reading and writing skills in a science program but confirms the need for continuation of such a program.

F. Results from Analysis of IPSP Problem Solving Test (Summary)

A form of the IPSP Problem Solving Test consisting of thirty multiple choice paper-pencil items was administered in a 35 minute time period to all the students involved in the program. This was done on a pre-test basis using two different versions of the instrument. The thirty items were scored as three subtests, each of which was designed to measure a skill which is presumed to be a prerequisite component of the ability to solve verbal problems. Part I reflects the ability to determine insufficient or extraneous information and to write a question for a problem setting. Part II is designed to measure the ability to choose the necessary computation, estimate or compute from a diagram or equation and to use a table effectively, while Part III is associated with the ability to look back, check a solution with the given conditions, vary the conditions, and relate problems that can be solved in a similar manner. A total score for the entire instrument was also obtained. The following table provides mean scores for each subtest as well as for the entire test on both the pre-test and the post-test.

MEAN SCORES ON THE IPSP PROBLEM SOLVING TEST

	pre-test	post-test
PART I	7.3099	6.8819
PART II	7.2082	6.9158
PART III	6.9158	6.8924
TOTAL	21.4339	20.6901

The sample size for the above data is 855, consisting of only those individuals for whom both pre-test and post-test scores were available. It should be noted that the pre-test sample size was 1286 while the post-test sample size was 1199. However, when individuals were matched, the sample size dropped to 855. This represents, not only a significant loss of students from the original sample, but also quite a large appendage of new students during the course of the study. It would seem that the population was rather unstable and exactly what effects this might have on the results of the study is not at all clear. Perhaps school officials should be consulted to see if there were any systematic changes occurring in the classes.

It should be noted that the mean scores on both the pre-test and the post-test for all three parts of the IPSP as well as for the total score are relatively high. In fact, 56% of the students scored 8 or better on Part I, 50.6% scored 8 or better on Part II, and 45.2% scored 8 or better on Part III, with 20.7%, 7%, and 10.4% of the

students getting all of the items correct on Parts I, II, III, respectively. One would expect the scores of the high scoring students to have a tendency to regress toward the mean. To be sure it would be difficult for many of these students to improve their scores. The complete frequency tables for both the pre-test and the post-test are contained in Appendix B.

In order to evaluate these data it was necessary to use a repeated-measures t-test and to focus upon difference scores (i.e. pre-test-post-test for each individual). The following table contains the mean difference scores for the three subtests and the total scores along with the associated standard errors, t-values and 2-tail probabilities. The degrees of freedom in all four analyses is 854.

DIFFERENCE SCORES ON THE IPSP PROBLEM SOLVING TEST

	MEAN DIFFERENCES	STANDARD ERROR	T VALUE	2-TAIL PROBABILITY
PART I	.4281	.067	6.34	.000
PART II	.2924	.066	4.44	.000
PART III	.0234	.070	0.33	.739
TOTAL	.7439	.133	5.60	.000

In further examining the pre-test/post-test scores for individaul students, it is quite evident that scores consistently tended to decrease from pre-test to post-test. This also would tend to raise the issue of whether the pre-test and the post-test were indeed equivalent forms. It may be that the post-test contained items that proved to be slightly more difficult for the students. If this were indeed the case, improvement which may have taken place would go undetected.

In interpreting these results it is also necessary to examine the more subtle influence of such factors as student motivation and teacher support and approval for the project. If student motivation is low or if the teacher has in some way conveyed to the students that their performance on these measures is not important, then it would be extremely difficult to obtain data demonstrating improvement over the course of the program.

A third mediating factor could be the length of time over which this study took place. Approximately three months elapsed between testing dates. It could be the case that such an education program requires a much longer period of time to effect discernible changes in problem solving habits.

Mean scores by subject and by teacher and subject as well as analyses of difference by subject and by teacher and subject are reported in Appendix B. Generally the

pattern described above is reflected in these data as well. This is, however, one instance in which improvement was noted on all three parts and on the total score. It maybe that the teacher in this case incorporated the components of problem solving more systematically into his classroom than did the other teachers. It would be advisable to use a self-report teacher questionnaire in subsequent studies to determine how much emphasis teachers placed upon introducing problem solving skills into their classroom. Surely the role of the teacher in the success of this program should not be overlooked. As in the tables reported in the body of this report, improvement in test scores is indicated by negative difference scores and negative t-scores.

V. Recommendations

Writing Across the Curriculum has proven to be an invaluable tool in teaching science. Therefore, the principle investigators feel that the CSU system should immediately support other Writing Across the Curriculum experiments.

Our recommendations have been substantiated by comments of the high school teachers. The comments of the high school teachers indicate that increased writing in the classes has substantially increased students' interests and positive attitudes toward the learning of science.

We have found that faculty participation is important to high school faculties if the college faculty are readily available throughout the school year. In our particular project, faculty members were on school sites on at least a weekly basis. With this amount of contact, strong, positive relationships developed among the college professors and the high school teachers.

Based on our positive results, it is our opinion that future projects who emphasize faculty involvement in the high schools be given priority in future funding.

With regard to funding, the teacher stipends have proved one of the least costly expenses incurred by the project. However, the teachers viewed this payment as proof that they were, indeed, part of the University commitment to upgrade high school education. But the actual dollars paid were less important than the prestige teachers felt by close association with the University.

The appointment of the H.S. Science Department Chairpersons as adjunct faculty in the SDSU Department of Natural Science was an important morale builder for each of the schools involved in the project. Therefore, our recommendation is that honorariums and stipends in addition to adjunct professorships be an integral part of any school/college program supported by the CSU system.

Success of the program is partially the result of

SDSU's working relationship with each of the high schools involved in the project. The Cooperative Writing Project had been involved three and a half years before this project started. This made start-up activities much easier. As a result, the principle investigators recommend that priority be given to those institutions who can demonstrate existing working relationships with the high schools.

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APPENDIX

A. An Assessment of Science Student Writing

B. Results from Analysis of IPSP Problem Solving Test

C. Maxigrant Continuation Questionnaire

D. Roster

Appendix A

ASSESSMENT OF STUDENT PROGRESS
IN THE
HIGH SCHOOL SCIENCE WRITING PROJECT

(This report is the result of a joint effort by Martha Johnson and Mary Anne Iverson Phillips. Mrs. Johnson represents San Diego State University (SDSU) in the Cooperative Writing Program and High School Science Program; she also presents workshops to help prepare science teachers to utilize writing in their classrooms. Ms. Phillips is a Graduate Instructor at SDSU specializing in Computer-Assisted Writing Instruction; she is also Computer Consultant for the Computer-Assisted Writing Instruction Center at Lincoln High School.

The data for the report was gathered by Martha Johnson with the help of Catherine Cisternino, a Graduate Assistant at SDSU Academic Skills Center. That data was subsequently analyzed by Ms. Phillips who then designed the tables in this report.)

An Assessment of Science Student Writing
1985

This year, three high schools from San Diego: Clairemont, Crawford, and Kearny joined the four high schools which were in the program last year: Hoover, Lincoln, Morse, and San Diego. Each school was first assigned an instructor who worked with the science teachers and then assigned tutors who worked directly in the science classrooms with the students and teachers.

Although the three new high schools were not in the program for the entire school year, their students demonstrated marked progress during the six months they did participate. However, the improvement of the schools participating last year and for this entire year is much more substantial than those new to the program.

The progress of each student was measured by administering a written pretest and posttest on site. Both tests were scored holistically as a uniform assignment following the example of Charles Cooper at UCSD. Martha Johnson led a team of instructors from SDSU in the scoring. Each paper was read twice unless a scoring difference of two points or more occurred; when a scoring difference occured, the paper was read a third time and the scores reconciled. The resulting student scores became the combined score of either the two readings or the reconciled score. To avoid counting the frequency of errors, a four point holistic guide was used by each of the readers. A copy of the following guide was distributed to each of the high schools with the test materials. It describes four levels of writing: Good Writing, Adequate Writing, Minimal Writing, and Inadequate Writing.

HOLISTIC SCORING

Holistic scoring is based on a reader reacting to a piece of writing as a whole--not in terms of certain traits or an absolute standard, but as a given assignment. Charles Cooper, a national authority on writing assessment, recommends holistic scoring as "the most valid and direct means of rank-ordering students by writing ability." Holistic scoring gets us closer to what is essential in communication than counting the frequency of errors.

Criteria for Scoring

The readers will follow a four point guide:

4 - Good writing addresses itself to the topic with thoroughness and accuracy. There is a clear focus, logical development and well chosen supportive detail. There are few mechanical errors.
3 - Adequate writing demonstrates knowlege of the topic and offers support, but there are some problems with accuracy and mechanics.
2 - Minimal writing generally lacks focus and has very little support. There are content errors as well as problems with mechanics.
1 - Inadequate writing is inaccurate, rambles and lacks development. There are numerous errors in usage and mechanics.

Each paper will be read twice, if there is a two point difference in scores, the paper will be read by a third reader and the scores reconciled. The student's score is the combined score of the two readings or the reconciled score.

7-8 good writing
5-6 adequate writing
3-4 minimal writing
-2 inadequate writing

Student examples of each writing level can be found in Attachment A.

The pretests were administered on site and scored at SDSU. The pretest scores below are of only those students who subsequently took the posttest.

PRETEST SCORES
OF
HIGH SCHOOL SCIENCE STUDENTS

	NUMBER OF PAPERS SCORING									
HIGH SCHOOL	8	7	6	5	4	3	2	1	0	TOTAL
Clairmont	11	8	26	29	38	9	23	0	3	147
Kearny	4	5	10	10	29	20	22	0	1	101
Crawford	12	1	15	4	19	7	13	0	0	71
Subtotals	27	14	51	43	86	36	58	0	4	319
Hoover	4	4	30	18	31	4	12	0	0	103
Lincoln	1	1	2	0	7	4	8	0	0	23
Morse	1	7	20	6	15	4	10	0	0	63
San Diego	3	0	9	4	17	19	47	0	1	100
Subtotals	9	12	61	28	70	31	77	0	1	289
Totals	36	26	112	71	156	67	135	0	5	608

At the time of the pretest, the largest number of students were writing at a minimally acceptable level and almost one-third of the students were writing below that level. Roughly, a mere one-sixth of the students could produce writing which unconditionally qualified as good writing.

The posttest question was delivered to each high school with a copy of the article to read for each student, with a copy of the scoring criteria, and testing instructions (see Attachment B: 1-4). The day prior to the test, a copy of the article was distributed to each student and then read to them. The students then participated in guided discussion. They were allowed to take the article home to study and reread; however, they were not allowed to refer to the article on the day of the posttest. The question for the posttest was distributed and read to the students just before they were given twenty minutes to write their response to the question.

The scores below are only of those students who took both the pretest and the posttest.

Posttest Scores
OF
HIGH SCHOOL SCIENCE STUDENTS

	NUMBER OF PAPERS SCORING									
HIGH SCHOOL	8	7	6	5	4	3	2	1	0	TOTAL
Clairemont	20	17	61	32	14	1	2	0	0	147
Kearny	6	3	38	16	34	4	0	0	0	101
Crawford	14	1	20	8	24	1	3	0	0	71
Subtotal	40	21	119	56	72	6	5	0	0	319
Hoover	4	7	31	19	34	2	6	0	0	103
Lincoln	2	1	6	5	6	2	1	0	0	23
Morse	9	7	27	8	12	0	0	0	0	63
San Diego	7	5	18	16	42	7	5	0	0	100
Subtotal	22	20	82	48	94	11	12	0	0	289
Totals	62	41	201	104	166	17	17	0	0	608

During the posttest, all but thirty-four students produced minimally acceptable writing or better. The number of students producing writing which unconditionally qualified as good writing almost doubled as did the number of students scoring seven and six.

Although a few students did not perform as well on the posttest as they did on the pretest, the majority of students either did as well or better on the posttest. The following table exhibits the numbers of students with an increased, decreased, or stable score.

NUMBER OF HIGH SCHOOL SCIENCE STUDENTS
DEMONSTRATING A DIFFERENCE IN PRETEST AND POSTTEST SCORES

	NUMBER OF STUDENTS DEMONSTRATING A DIFFERENCE												
HIGH SCHOOL	+6	+5	+4	+3	+2	+1	+0	-1	-2	-3	-4	-5	TOTAL
Clairmont	1	8	11	16	32	29	28	13	6	2	1	0	147
Kearny	1	1	10	11	21	23	20	9	4	0	1	0	101
Crawford	0	0	4	4	22	9	23	3	4	1	0	1	71
Subtotal	2	9	25	31	75	61	71	25	14	3	2	1	319
Hoover	0	1	0	7	20	11	38	11	13	1	1	0	103
Lincoln	0	0	0	4	8	6	4	1	0	0	0	0	23
Morse	0	1	4	5	18	13	15	4	2	1	0	0	63
San Diego	1	1	9	11	38	20	13	2	5	0	0	0	100
Subtotal	1	3	13	27	84	50	70	18	20	2	1	0	289
Total	3	12	38	58	159	111	141	43	34	5	3	1	608

Many factors such as no breakfast, emotional state, and stress could have caused any student to write a paper which would receive a lower score than would exhibit the student's capability. However, as the table indicates, more than 62.5% of the students wrote papers of better quality on the posttest than on the pretest.

Throughout this report, the scores of the schools who participated in the program last year and for the full 1984-85 school year have been grouped and subtotaled separately from the three schools who began the program midway during this school year. This has been done to contrast the improvement of those students participating in the program for a full school year against the improvement of those students participating for only six months. The following table highlights the differences in the percentages between the two groups of schools.

PERCENTAGE OF HIGH SCHOOL SCIENCE STUDENTS WITHIN EACH WRITING CATEGORY

COMPARING THOSE STUDENTS IN THE PROGRAM FOR NINE MONTHS
WITH THOSE IN THE PROGRAM FOR FIVE MONTHS

MONTH HIGH SCHOOL BEGAN THE SCIENCE WRITING PROGRAM	PRETEST	POSTTEST	DIFFERENCE
	PERCENTAGE OF STUDENTS SCORING IN GOOD WRITING RANGE		
SEPT	.07 %	.15 %	0.08 %
JAN	.13 %	.19 %	0.06 %
	PERCENTAGE OF STUDENTS SCORING IN ADEQUATE WRITING RANGE		
SEPT	.31 %	.45 %	0.14 %
JAN	.29 %	.55 %	0.26 %
	PERCENTAGE OF STUDENTS SCORING IN MINIMAL WRITING RANGE		
SEPT	.35 %	.36 %	0.01 %
JAN	.38 %	.24 %	-0.14 %
	PERCENTAGE OF STUDENTS SCORING IN INADEQUATE WRITING RANGE		
SEPT	.27 %	.04 %	-0.23 %
JAN	.19 %	.02 %	-0.17 %

Quantitative differences appear in the percentages between pretest and posttest. The students from the three schools new to the program showed marked improvements in their writing, but the percentages for the students who were in the program for the year were even more impressive. Students from Crawford, Kearny, and Clairmont High Schools (the schools new to the program) showed an improvement of 6% on the good writing, 26% on the adequate writing, and 14% on the minimal writing. This left 17% fewer students in the inadequate writing category. However, the scores of students from Hoover, Lincoln, Morse, and San Diego High Schools improved more dramatically. These students, in the program for the full year, more than doubled the number of students in the good writing category, and the number in the adequate writing category increased by 14%. The minimal writing category remained almost the same, but the inadequate writing category dropped by 23%.

After completing the scoring, Martha Johnson presented the high schools with letters complimenting them on their accomplishments with the science students and with individualized letters for each student scoring an eight or increasing their score by three or more points. Thus the students with the most progress received a tangible reward for their newly developed skill.

ATTACHMENT A

** Sample Student Response For A Score Of Four 1985 (Twenty Minute Time Limit) **

Criteria:

A score of four indicates good writing and addresses itself to the topic with thoroughness and accuracy. Not only does the writing exhibit a clear focus, logical development, and well chosen supportive detail, but there are few mechanical errors.

Sample:

Writing in Science: Post Test 1985

Science and art have long been categorized as two separate and distinct things. There are those who believe in science and those who belive in art and the two never seem to meet. Yet they do have a lot in common. Medicine is a science, but is not a surgeon's skill a form of art? Sculpting is an art, but doesn't the sculptor use math to determine shapes and angles? Although artists and scientists see their work as quite different, they're actually very close. If the two cooperated more, perhaps each could better their trade. An artist can help scientists to see beauty in science and to break away from strict adherence to rules. Maybe if more scientists were dreamers, we would discovered as much as we have a lot sooner. Science can help art improve and transcend itself by giving artists new ideas and lending some of its rules. Maybe if their was more science in art, others would be ale to understand art better. The meeting of art and science would enhance our knowledge and join the "two parts of the world" together.

** Sample Student Response For A Score Of Three 1985 (Twenty Minute Time Limit) **

Criteria:

A score of three indicates adequate writing; however, although the paper demonstrates the student's knowledge of the topic and offers support, there are some problems with accuracy and mechanics.

Sample:

Scientists and artists are very much alike. They are always finding new ways of looking at life. An artist always finds a new way of painting a picture so he puts his ideas on canvas. A scientist also finds new mehods of study so he puts his ideas down on paper. The public may like or dislike a painting and they may also agree or disagree with a scientists ideas. It is important for scientists and artists to share ideas with each other because an artist, in his way of looking at life, can discover something that may be important to a scientist, and a scientist may help an artist express himself better through art. Most important, though, is the fact that they are both working with life and they can discover it better working together.

** Sample Student Response For A Score Of Two 1985 (Twenty Minute Time Limit) **

Criteria:

A score of two indicates minimal writing and generally lacks focus with very little support. There are content errors as well as problems with mechanics.

Sample:

Scientists and artists both experiment with new ideas. It is important for them to share their ideas with each other so that they can combine their ideas and make them better. They can experiment with both ideas, and see which one is best for something, or if their both good, or if it would be better if the combined them.

** Sample Student Response for a score of One 1985 (Twenty-minute Time Limit) **

Criteria:

A score of one indicates inadequate writing which is inaccurate, rambles, and undeveloped. There are numerous errors in usage and mechanics.

Two Samples:

(Sample 1) Science, Art, and Tolerance

Both create new knowledge and news ways of looking at ourselves and at the world.

****

(Sample 2)

Scientists and artistic should share their problems and idea with each other, because they have things in common. Such as discoveries and art are also alike and I think they can help each other out by sharing their idea together. They can also solve each other problem on each other ideas. Just sit and work them out.

ATTACHMENT 8

SCIENCE, ART, and TOLERANCE

Robert T. Brown

"I don't care what others do with my discoveries. I don't care what sacrifices must be made or what the cost is. Nothing can stand in the way of my research!" So says the movie scientist, in a predictably heavy German accent, as his assistants go about carrying out his research by zapping people with laser beams or testing some new exotic nerve gas on them.

The movie and television stereotype of the scientist is familiar-a demented egomaniac who commits hideous crimes in order to conduct outrageous experiments. From Dr. Frankenstein to Dr. No, the scientist as madman and science as somehow evil have become part of our culture. This view is also transmitted to our children-consider the treacherous, if bumbling Dr. Smith on "Lost in Space" and all the evil scientists on cartoon shows.

Science is a particularly misunderstood form of knowledge. Our culture's lack of knowledge about science and how it works, and about the scientists and how they work, is disturbing, particularly considering the importance of science in contemporary life. Some years ago, British novelist and scientist, C.P. Snow suggested that our intellectual society was split into two cultures, one scientific and the other literary and artistic, with a gulf of mutual incomprehension between them.

But what do the scientists and artists do? First of all, both create new knowledge and new ways of looking at ourselves and at our world. Further, both science and art have aesthetic qualities, and the same words-beautiful, powerful, sensitive-that are used to describe a poem, sonata, or painting, are also used to describe research and theory. Indeed, the emotion in both artist and scientist must be similar when they reflect on a completed work.

Further, an artistic work, like a scientific one, is of no value until it is presented to others. The author's "great unwritten novel" or the artist's "great unpainted painting" are of no more value than the scientist's "great unpublished experiment." Ideas are cheap; it is products that are dear. Thus, science and art are both public.

In both science and art, true creativity is characterized by those who find a new way of looking at reality-and thereby change our own view of the world. Reality exists by common agreement and is subject to change. And let there be no mistake-reality has changed several times for Western humanity over the last several hundred years. Before Copernicus, reality was that the other planets and the sun revolved around the earth, which was at the center of the universe. Copernicus changed all that, although we still talk of the sun rising and setting! Reality also changed after Darwin, Freud, and Einstein, never to be the same again. But reality also changed after Monet, James Joyce, and Stravinsky, never to be the same again. Scientist and artist each provided a new view of the way the world is put together.

Yet those views are quite different. The scientist's view must be open to rigorous testing; the artist's is very much a personal view. If some artistic views are considered better than others, it certainly must be on grounds other than objective observation. An artist saying to another, "No, you are wrong; this is the way the world really is," is ludicrous. But scientists have arguments like that all the time. Some have been going on for hundreds of years.

A further difference between science and art is the scientific method that defines science. Perhaps the crucial difference is that the truly creative scientist expands our view of reality by finding a new way to follow his rules, whereas the truly creative artist expands our view of reality by finding a new way to break accepted rules.

But scientists and artists share a common bond: in neither field can there be a complete, final answer. Both constantly change; neither is exact. Both share the crucial need for tolerance of other views in order to survive; both should stand together against intolerance and dogma. Artists were in Nazi concentration camps with scientists. In Russia, artists and scientists are together today in the Gulag Archipelago.

Robert Benchley once said, "The world is divided into two parts-those who divide the world into two parts and those who do not." I prefer to be among those who do not. Art and science are both very human forms of knowledge. In the words of Jacob Bronowski, both an artist and a scientist, "We must cure ourselves of the itch for absolute knowledge and power...We must touch people..."

(2) WRITING IN SCIENCE
POSTTEST 1985

High School Student Robert T. Brown wrote the essay "Science, Art, and Tolerance," because he felt that the split between artistic and scientific knowledge described by C. P. Snow continues to the detriment of us all. Many problems remain unsolved because scientists and those in the humanities don't share their insight, their way of exploring problems—they don't even share their discoveries. Robert Brown hopes to encourage a dialogue between the dicipiines by helping scientists and artists become aware of how much they have in common.

Question:

In a fully developed paragraph (1/2 to 1 page in length) discuss what scientists and artists have in common and why it is important for them to share ideas with each other.

(3) Science Maxigrant Writing Assessment, 1984-85

The purpose of this year's assessment is twofold:

1. To measure students' progress in answering a question with a fully developed paragraph - a paragraph that has a clear focus, well chosen supportive detail and few mechanical errors.

2. To help us make recommendations for strengthening the writing program next year.

Instructions for the posttest (the week of May 13)

1. The day before they are asked to write, give each student a copy of the essay; read it to them and discuss it. Do not let them know what the question will be.

2. Just before they begin writing, give each a copy of the question and read it aloud.

3. Tell them they will have 20 minutes to write their response. Ask them to put their name, the course, the period and date in the upper right-hand corner.

4. Be sure their desks are clear. They are not to use notes or refer to the essay.

5. Give the papers to the Department Chairman who will mail them to:

   Martha Johnson
   Academic Skills Center
   San Diego State University
   San Diego, California 92182

   *All papers should be mailed no later than Monday, May 21.

6. Each school will receive the pre and post-test scores by June 6.

7. Letters of commendation will be sent to students who have made the most progress with their writing and to those with the highest scores.

** Attached: Posttest essay and question.
Definition of holistic scoring and scoring guide.

APPENDIX B

IPSP PROBLEM SOLVING IPSP PROBLEM SOLVING TEST, PART I
Distribution of Raw Scores

	PRETEST			POSTTEST		
SCORE	ABS FREQ	PCT	CUM FREQ	ABS FREQ	PCT	CUM FREQ
0	3	.4	.4	0	.0	.0
1	9	1.1	1.4	8	.9	.9
2	21	2.5	3.9	15	1.8	2.7
3	40	4.7	8.5	41	4.8	7.5
4	53	6.2	14.7	80	9.4	16.8
5	74	8.7	23.4	77	9.0	25.8
6	80	9.4	32.7	127	14.9	40.7
7	96	11.2	44.0	136	15.9	56.6
8	143	16.7	60.7	146	17.1	73.7
9	159	18.6	79.3	114	13.3	87.0
10	177	20.7	100.0	111	13.0	100.0

IPSP PROBLEM SOLVING TEST, PART II
Distribution of Raw Scores

	PRETEST			POSTTEST		
SCORE	ABS FREQ	PCT	CUM FREQ	ABS FREQ	PCT	CUM FREQ
0	0	.0	.0	0	.0	.0
1	6	.7	.7	8	.9	.9
2	8	.9	1.6	15	1.8	2.7
3	25	2.9	4.6	43	5.0	7.7
4	47	5.5	10.1	60	7.0	14.7
5	70	8.2	18.2	91	10.6	25.4
6	109	12.7	31.0	104	12.2	37.5
7	157	18.4	49.4	136	15.9	53.5
8	182	21.3	70.6	159	18.6	72.0
9	191	22.3	93.0	187	21.9	93.9
10	60	7.0	100.0	52	6.1	100.0

IPSP PROBLEM SOLVING TEST, PART III
Distribution of Raw Scores

	PRETEST			POSTTEST		
SCORE	ABS FREQ	PCT	CUM FREQ	ABS FREQ	PCT	CUM FREQ
0	0	.0	.0	5	.6	.6
1	10	1.2	1.2	13	1.5	2.1
2	19	2.2	3.4	28	3.3	5.4
3	37	4.3	7.7	44	5.1	10.5
4	59	6.9	14.6	69	8.1	18.6
5	97	11.3	26.0	79	9.2	27.8
6	108	12.6	38.6	91	10.6	38.5
7	139	16.3	54.9	112	13.1	51.6
8	151	17.7	72.5	149	17.4	69.0
9	146	17.1	89.6	151	17.7	86.7
10	89	10.4	100.0	114	13.3	100.0

* * SUMMARY OF RESULTS FOR BIOLOGY * *

N = 556

MEAN SCORES ON THE IPSP PROBLEM SOLVING TEST

	PRETEST	POSTTEST
PART I	6.8957	6.5018
PART II	6.9604	6.6457
PART III	6.6205	6.5342
TOTAL	20.4766	19.6817

DIFFERENCE SCORES ON THE IPSP PROBLEM SOLVING TEST

	MEAN DIFFERENCES	STANDARD ERROR	T VALUE	2-TAIL PROBABILITY
PART I	.3939	.088	4.48	.000
PART II	.3147	.084	3.75	.000
PART III	.0863	.090	0.95	.340
TOTAL	.7950	.173	4.59	.000

* * SUMMARY OF RESULTS FOR CHEMISTRY * *

N = 182

MEAN SCORES ON THE IPSP PROBLEM SOLVING TEST

	PRETEST	POSTTEST
PART I	8.0495	7.4890
PART II	7.7033	7.4011
PART III	7.5659	7.5824
TOTAL	23.3187	22.4725

DIFFERENCE SCORES ON THE IPSP PROBEM SOLVING TEST

	MEAN DIFFERENCES	STANDARD ERROR	T VALUE	2-TAIL PROBABILITY
PART I	.5604	.133	4.21	.000
PART II	.3022	.139	2.18	.031
PART III	-.0165	.153	-0.11	.914
TOTAL	.8462	.273	3.10	.002

* * SUMMARY OF RESULTS FOR PHYSICS * *

N =88

MEAN SCORES OF THE IPSP PROBLEM SOLVING TEST

	PRETEST	POSTTEST
PART I	8.6023	8.0682
PART II	7.8636	7.8295
PART III	7.7045	8.0568
TOTAL	24.1705	23.9545

DIFFERENCE SCORES ON THE IPSP PROBLEM SOLVING TEST

	MEAN DIFFERENCES	STANDARD ERROR	T VALUE	2-TAIL PROBABILITY
PART I	.5341	.154	3.46	.001
PART II	.0341	.178	.19	.849
PART III	-.3523	.159	-2.21	.030
TOTAL	.2159	.318	.68	.499